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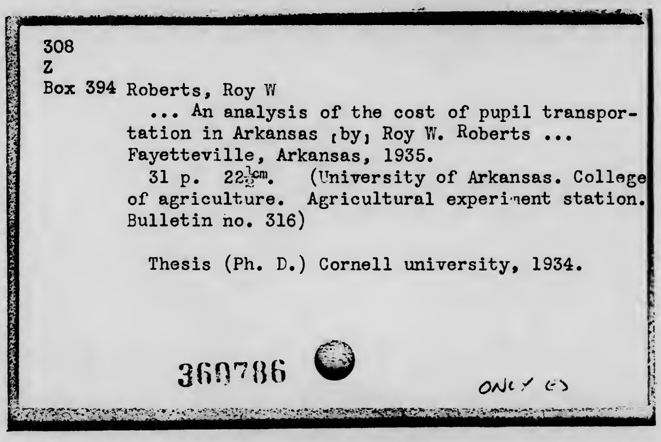

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BY

ROY W. ROBERTS

September, 1934

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Agricultural Experiment Station

Main Station, University; with Cotton Branch Station, Lee County
Rice Branch Station, Arkansas County; Fruit and
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An Analysis of the Cost of Pupil Transportation in Arkansas

ROY W. ROBERTS

BULLETIN NO. 316

C. O. BRANNEN, Acting Director

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April, 1935

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AN ANALYSIS OF THE COST OF PUPIL TRANSPORTATION IN ARKANSAS

ROY W. ROBERTS
Department of Agricultural Education

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Rural school consolidation is one of the methods adopted to provide standard schools for pupils in sparsely settled areas. Since Arkansas is predominately a rural state, consolidated schools will constitute an important part of the educational program of the state for many years to come. Consolidated schools serve large areas and provide secondary school facilities for many pupils who would otherwise be deprived of high school advantages. Many pupils in these consolidated districts live beyond a reasonable walking distance from the school house and therefore must be transported to and from school. The transportation of public school pupils is now generally accepted as a function of the state school system, and bus routes have been established in practically all the consolidated school districts of the state. Transportation of pupils, therefore, must be taken into account as a part of school costs, and school directors are faced with the problem of maintaining satisfactory transportation facilities at a minimum cost[1].

The beginnings of consolidation and transportation in Arkansas occurred in 1911 with the passage of the first consolidation law. The Legislature of 1919 passed the first state pupil transportation law, authorizing boards of directors in all districts to provide for pupil transportation. In the school year 1919-20, there were 1,032 pupils transported, and by 1931-32 this number had increased to 52,654 (Table 1). The cost of transporting pupils to schools in Arkansas in 1930-31 was $748,976. While this amount was less than 6 per cent of the total current expenses for the 3,112 school districts, it represents a much larger percentage of the expense of the school districts providing such transportation. About 69 per cent of the total cost was expended

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[1] This study is part of a research program on farm taxation and public expenditures conducted by the Department of Rural Economics and Sociology.

TABLE 1. THE DEVELOPMENT OF PUPIL TRANSPORTATION AND CONSOLIDATION IN ARKANSAS, 1919-1934

Year	One-room schools	Pupils transported	School buses	Cost of transportation
	Number	*Number*	*Number*	*Dollars*
1919-20	5,215[1]	1,032[2]		
1920-21*				
1921-22[3]	3,800			
1922-23*				
1923-24[3]	4,329			10,000
1924-25*				
1925-26	4,303[3]	3,136[4]	108[4]	50,000[3]
1926-27*				
1927-28[4]	3,758	9,694	262	169,980
1928-29[5]		13,433	391	
1929-30[4]	3,134	24,563	655	
1930-31[4]	2,843	46,878	1,212	748,976
1931-32[4]	2,707	52,654	1,290	592,660
1932-33*				
1933-34[6]			1,169	529,584

[1] Consolidation of Schools and Transportation of Pupils, U. S. Office of Education Bul. No. 41, 1923.

[2] Recent Data on Consolidation of Schools and Transportation of Pupils, U. S. Office of Education Bul. No. 22, 1925.

[3] Rural School Consolidation, U. S. Office of Education Pamphlet No. 6, 1930.

[4] Biennial Report of Arkansas State Commissioner of Education, 1930-31 and 1931-32.

[5] Biennial Report of Arkansas State Superintendent of Public Instruction, 1928-29 and 1929-30.

[6] State Department of Education.

*No data available.

in the 261 school districts receiving state aid for pupil transportation.

METHOD OF THE STUDY

This study is confined largely to an analysis of the factors affecting cost and to the validity of predicting cost from these factors. The attempt is made to ascertain the cost per pupil of transportation under varying conditions. Comparison is made of the cost, as found, to cost rates allowed under state regulations.

The cost data used in this study are for the 261 Arkansas school districts receiving state aid for pupil transportation in 1930-31. The aggregate cost of transportation in these districts was $517,492. These districts transported about two-thirds of the total number of pupils transported in the state in 1930-31. The cost data are assembled under two headings, current expense and property outlay. The cost items included under current expense are: Salaries; gas, oil, and grease; maintenance of vehicles, buildings, and equipment; insurance; rentals; and contracts. The property outlay items consist of: Capital outlay, depreciation, and interest. Depreciation is taken at 20 per cent per annum of the cost (new) of the bus, and interest at 5 per cent per annum on the average investment. The cost data are shown separately for contract and school-owned buses.

The regulations for granting state aid for pupil transportation read as follows:

> "Section 9. *Expense of transportation.* The budget allowance for transportation shall be calculated on the following schedule based on distance traveled one way, on the most direct and practical route; provided, that if transportation is by contract, a greater amount shall not be allowed than the contract price. Children who live within two miles of the school, and ride, must not be counted. Pupils must reside in the district in which the school they attend is located, or must be legally transferred to such district to be eligible for allowance on transportation.
>
> "$2.50 per month per pupil in average daily attendance for the first twenty pupils or less for each bus route.
>
> "$1.50 per month per pupil in average daily attendance for the next ten pupils.
>
> "$1.00 per month per pupil in average daily attendance for pupils in excess of thirty.
>
> "An additional allowance per bus per month will be granted as follows, provided the bus carries an average of twenty or more pupils:
>
> "$3.00 for each mile in excess of five miles one way, provided such excess mileage accommodates enough children to justify the additional expenditure. The maximum amount allowed for excess mileage shall not exceed $3.00 per month per child transported over such excess mileage.
>
> "$1.00 for each mile of dirt road, one way.
>
> "A list for each bus route, giving the name of each pupil eligible for free transportation shall be filed with the county superintendent at the beginning of the school term. This list shall be revised as changes take place. The distance that each pupil walks and the distance that he rides shall be given. A map of each bus route, showing by dots the residence of each pupil transported, shall also be filed with the county superintendent. Children are expected to walk a reasonable distance to the bus line. Allowances can not be made for excess mileage caused by buses making circuitous routes to go by the homes of children who can reach the direct bus line by walking a reasonable distance."

These regulations indicate that aid for pupil transportation is granted on the basis of the number of pupils, type of road, and length of bus route. This implies that the cost of transportation is dependent on the factors of transportation, and that a cost estimate may be arrived at from an analysis of the factors affecting cost. This estimate may be used to determine the approximate cost of new or proposed transportation projects where the factors are known. The analysis of the items and factors of cost included in this study also provide data which may prove helpful to school directors in a study of the efficiency and economy of their individual transportation programs.

COST OF PUPIL TRANSPORTATION

Variations in cost from year to year due to economic conditions make it rather difficult to determine specific costs that hold for any length of time. Then, too, variations in reporting forms and accounting practices tend to limit comparisons between and even within states. These difficulties make certain descriptive facts a necessary part of any cost study.

The 261 Arkansas school districts receiving state aid for pupil transportation in 1930-31 used 355 school-owned, 393 contract, and 187 private vehicles for transporting pupils to and from school. Fifty-one per cent of the pupils were transported in school-owned buses, 47 per cent in contract, and 2 per cent in privately-owned cars. The average route mileage one way for the school-owned buses was 12, and for the contract buses 9.8[2]. The school-owned buses transported an average of 44 pupils per day and the contract buses 36. The districts transported an average of 118 pupils, which represented about 45 per cent of the average daily attendance in these districts. The district route mileage one way averaged 23.5 miles of dirt road, 6.5 miles of gravel, and 3.6 miles of paved road.

Cost per pupil. The greater part of the state aid in Arkansas is based on the unit cost per pupil per month. The cost per pupil per month for school-owned buses is 54 cents less than for contract, and 82 cents less than for private cars (Table 2).

TABLE 2. COST OF TRANSPORTATION PER PUPIL, 935 BUSES, 1930-31

Type of ownership	Number of vehicles	Average cost of transportation per pupil			
		Per year	Per month	Per day	Per pupil mile[1]
		Dollars	*Dollars*	*Cents*	*Cents*
School-owned	355	15.21	2.02	10.1	.6
Contract	393	18.84	2.56	12.8	.7
Private	187	17.65	2.84	14.2	1.9
Average		16.94	2.36	11.4	.7

[1] The cost per pupil mile is computed by multiplying the aggregate number of pupils transported per bus per year by the average daily mileage of the bus and dividing this product into the yearly cost of transportation.

Some of this difference is undoubtedly due to the fact that school-owned buses transport about 22 per cent more pupils than contract buses. Since certain items of cost such as depreciation, interest, and salaries do not change correspondingly with changes in numbers transported, an increase in the number of pupils transported has the effect of decreasing the cost per pupil.

TABLE 3. COST OF PUPIL TRANSPORTATION PER BUS, 935 BUSES, 1930-31

Type of ownership	Number of buses	Average cost of transportation per bus		
		Per year	Per day	Per bus mile
		Dollars	*Dollars*	*Cents*
School-owned	355	662	4.39	18.9
Contract	393	685	4.66	24.0
Private	187	70	.56	7.4
Average		553	3.85	20.3

Cost per bus. The cost per bus per day and per year are not units of measurement in the ordinary sense, but they are related to factors affecting cost. The average cost per bus per year for school-owned transportation is $662, per day $4.39, and per bus mile 18.9 cents (Table 3). Here again school-owned transportation seems to be less expensive per unit than contracted transportation. The widest margin of difference appears in the cost per bus mile, but again it should be remembered that school-owned buses travel a greater distance per day. Since the capital costs do not change in accordance with changes in route mileage, some of this unit cost may be explained by mileage rather than type of ownership.

Distribution of cost. A useful means of making comparisons in transportation accounting is to compare items of cost in different transportation projects. Frequently, excessively low or high unit costs may be explained by an examination of the items making up total cost. The distribution of cost per bus per year for the 355 school-owned buses used in the 261 districts described in this study shows that salary and depreciation represent the two largest items of cost (Table 4). Wide ranges are shown in the cost of each of the items due to the many factors affecting cost of transportation. The items of cost dependent largely on managerial practices are salary of driver, insurance and storage, depreciation, and interest. These make up 71 per cent of the total cost of pupil transportation. Gas and oil, and maintanance

TABLE 4. ANALYSIS OF COST OF PUPIL TRANSPORTATION, 355 SCHOOL-OWNED BUSES, 1930-31

Item of cost	Cost per bus per year		Part of total cost
	Range	Average	
	Dollars	*Dollars*	*Per cent*
Salary of driver	12 — 720	214.51	32.3
Gas and oil	4 — 487	130.59	19.7
Maintenance	0 — 416	61.96	9.3
Insurance and storage	0 — 83	7.69	1.2
Depreciation	17 — 540	207.46	31.3
Interest	1.50 — 99	40.24	6.2
Total		662.45	100.0

---

[2] The term "route mileage one way" refers to the distance from the school house to the farther-most point on the route over which the bus travels. If the route is circular, the distance traveled per trip is the route mileage one way.

represent 29 per cent of the total. Insurance and storage represent a small part of the total cost because of the small number of buses that are insured and properly stored. The average cost per bus per year for buses reporting insurance and storage is $42.34. The low pupil per day and per mile values represented by the cost of maintenance, insurance and storage, and interest (Appendix Table 1) make these units less desirable for use in cost comparisons because of the great chance of error involved in making calculations from these small values.

One of the most troublesome items of cost is the charge for administration. In the first place there is little agreement among administrators as to what items are chargeable under this heading, and there is some basis for charging administration to general control. School administrators spent an average of 4.3 hours per week in 1930-31 in loading and unloading buses and in keeping transportation records. Almost twice as much time was spent in loading and unloading as in record keeping, and the administration of transportation under contract was slightly less time-consuming than under school-owned transportation. The saving of time was effected in the supervision of loading and unloading pupils. No data are available on the cost per hour for administering transportation, and in the absence of these and other specific data this item is usually not found in transportation costs and is not included in the cost data of this study.

Valid comparisons of the cost of pupil transportation in different states are difficult to make because of differences in transportation accounting practices and standards. An attempt, however, is made to show a comparison of cost data from this study with those from California, North Carolina, South Carolina, and Wyoming. The cost data of Arkansas compare favorably with those of other states in so far as economy of transportation is concerned (Table 5). One factor not considered here has to do with the comfort and safety of the vehicle used for transporting pupils. Since a greater part of the cost of transportation is represented in depreciation of buses and salaries of drivers, it is entirely possible that unsatisfactory transportation equipment and careless drivers may represent false economy in pupil transportation costs.

Cost comparisons are ordinarily based on unit costs. However, the selecting of a single unit of cost, such as the bus mile or pupil mile, for comparing the cost of different pupil transportation projects, involves difficulties, as Evans has shown[3], ordinarily not found in the commercial world. Comparisons on the basis of cost per bus mile are conditioned by large or small, old

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[3] Evans, F. O., Factors Affecting the Cost of School Transportation in California, Bulletin No. 29, 1930, U. S. Office of Education.

TABLE 5. COST OF PUPIL TRANSPORTATION IN ARKANSAS, CALIFORNIA, NORTH CAROLINA, SOUTH CAROLINA, AND WYOMING

Unit of Cost	Arkansas[1] 1930-31	California[2] 1926-27	North Carolina[3] 1930-31	South Carolina[4] 1930-31	Wyoming[5] 1929-30
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Pupil per year	15.21	41.35	10.85	20.95	66.32
Pupil per day	.10	.23	.07	.13	.37
Pupil mile	.006	.007	.005	.006	.009
Bus per year	662.00	1,593.00	513.00	552.00	1,101.00
Bus per day	4.39	8.33	3.02	3.76	6.27
Bus mile	.19	.22	.11	.15	.35
Driver's salary per year	214.51	470.00			819.00
Gas and oil per bus mile	.037	.021			
Maintenance per bus mile	.018	.021			.036
Depreciation per bus mile	.059	.073			
Interest per bus mile	.011	.015			

[1] The averages shown are for the 355 school-owned buses.

[2] Factors Affecting the Cost of School Transportation in California, U. S. Office of Education Bul. No. 29, 1930.

[3] Public School Bus Transportation in North Carolina, State Department of Education Publication No. 172, 1932.

[4] A Statistical Study of School Transportation in South Carolina, State Department of Education Monograph, 1931.

[5] Current Transportation Practices in Wyoming, State Department of Education Publication, 1931.

or new, high or low priced buses; transporting pupils over paved, gravel, or dirt roads; operated by a parent, teacher, or pupil; careful or careless drivers; all of which affect the cost per bus mile. These facts suggest that several different units, together with certain descriptive facts, are more satisfactory than a single unit for comparing the efficiency of pupil transportation projects. Some important descriptive facts and averages are shown on the factor sheet, page 31 of this bulletin.

ANALYSIS OF FACTORS AFFECTING COST

A prediction of cost involves a factor analysis to determine the significant factors affecting cost, and a measurement of changes in cost brought about by changes in the significant factors. The factors selected for analysis in this report are taken from representative studies in pupil transportation and are classified under the following divisions. *Factors relating to pupils*: Number of pupils transported per year, per bus load, and per bus per day. *Factors relating to bus routes*: Type of road, length of route, number of round trips per day, and bus mileage per year. *Factors relating to buses*: Days operated per year, seating capacity, ownership, make, cost, and age. *Factors relating to bus drivers*: Age and vocation. *Factors relating to school districts*: Topography of district and purchasing policies of school board. The factors are analyzed in the order indicated above.

Pupils transported. The cost per bus per day increases and the costs per pupil per day and per pupil mile decrease as the number of pupils transported per year increases (Appendix Table 2). The increase in the number of pupils transported per year is accompanied by an increase in the average number transported per day, and the average route mileage per bus one way, indicating that the increase in cost of transportation is due in part to pupil load and to the distance pupils are transported. An analysis of the data for contract buses shows that changes in the cost of contract transportation are accompanied by changes in the number of pupils per bus per day and route mileage per bus one way. The cost per bus per day increases with the increased pupil load. The cost per pupil per day and per pupil mile decrease with an increase in pupil load up to 8,000 pupils per year and increase thereafter.

When the bus data are grouped according to the number of pupils transported per bus per year and subdivided on the basis of the route mileage per bus one way, the contract buses show a wider range in cost of transportation than the school-owned buses (Table 6). The range in cost of school-owned transportation is less for the shorter hauls than for the longer hauls, and for contract buses the reverse is true. Changes in the number of pupils transported per bus per year bring about greater changes in the cost of contract transportation per bus per day than in the cost of school-owned transportation. It is interesting in this connection to recall that the Arkansas state plan for estimating the maximum state allowance for pupil transportation recognizes the number of pupils transported as the basic factor in the calculation of the amount of state allowance. The cost of transportation per bus per day increases with the number of pupils transported per bus load. An average increase of 40 pupils transported is accompanied by an increase of $1.68 in the daily cost of transportation.

TABLE 6. COMPARATIVE EFFECT OF AGGREGATE NUMBER OF PUPILS TRANSPORTED PER YEAR AND ROUTE MILEAGE ON THE COST OF PUPIL TRANSPORTATION, 598 BUSES, 1930-31[1]

Aggregate number of pupils per bus per year	Route mileage per bus one way	Cost of transportation per bus per day: School-owned buses	Cost of transportation per bus per day: Contract buses
	Miles	*Dollars*	*Dollars*
Less than 4,000	Less than 10	3.71	2.29
	10 or more	3.99	5.06
4,000-6,999	Less than 10	3.94	4.23
	10 or more	4.35	5.16
7,000 or more	Less than 10	3.89	5.39
	10 or more	4.89	6.67

[1] The data are for buses operating 150-169 days per year.

TABLE 7. RELATION OF NUMBER OF PUPILS TRANSPORTED PER DAY TO COST OF PUPIL TRANSPORTATION, 748 BUSES, 1930-31

Pupils transported per bus per day	School-owned transportation: Number of buses	School-owned transportation: Average cost per bus per day	School-owned transportation: Pupils transported per bus per yr., average	Contract transportation: Number of buses	Contract transportation: Average cost per bus per day	Contract transportation: Pupils transported per bus per yr., average
		Dollars	*Number*		*Dollars*	*Number*
Less than 20	15	3.50	2,665	61	2.30	1,951
20 - 29	66	4.02	3,792	86	3.96	3,723
30 - 39	88	4.11	5,341	100	4.64	5,198
40 - 49	76	4.48	6,679	71	5.29	6,724
50 - 59	40	4.40	8,030	38	6.05	8,106
60 - 69	36	4.76	9,413	24	7.32	9,248
70 - 79	13	5.32	9,774	9	7.39	9,943
80 - 89	8	5.38	11,643	3	6.46	9,129
90 - 99	5	5.90	13,312	1	7.96	15,004
100 or more	8	5.98	15,179	0		

Some buses transport two or more loads of pupils each day either over two or more routes or over the same route. This procedure has the effect of increasing the number of pupils transported per bus per year, thereby reducing the cost per pupil. The cost per day for contract transportation is less for smaller loads and more for larger loads than the cost of school-owned transportation, the change in ratio occurring at the 30-39 pupil group (Table 7). It should be remembered, however, that the school-owned buses travel a greater number of bus miles and operate more days per year than the contract buses. These data show a more gradual increase in cost per day and a wider range of cost than that caused by the factor of pupils per bus per load and suggest that changes in the number of pupils transported per day occasion more significant changes in cost than is caused by changes in the average number per load. Since the number of pupils transported per bus per day also takes into account the buses making more than one round trip per day, it is selected for use in the cost analysis as the most satisfactory expression of the number of pupils transported.

Bus routes. The cost per bus per day is less for dirt roads than for roads having some paved or gravel mileage and increases with an increase in the route mileage for each type of road (Appendix Table 3). The cost per bus mile is less for the paved and gravel roads than for the dirt and decreases with an increase in mileage on each type of road. Buses operating over dirt roads only, travel fewer miles per day and transport fewer pupils. The fact that the cost per bus mile is dependent on the number of bus miles traveled offers some explanation for the high cost per bus mile for the buses included in the "dirt" group.

The daily cost per bus of contract transportation is more for improved road than for unimproved, and increases with the route mileage. The variation in the cost per bus mile is not as great as that shown for school-owned buses, and there is little difference in cost between the "paved" and "dirt" groups. The buses operating only on dirt roads transport fewer pupils and travel fewer miles per day.

These data are difficult to interpret because of the few miles of improved road and the interaction of the mileage and pupil factors. The increase in the cost of transportation as the improved route mileage increases may be due in part to changes in the number of pupils transported and bus miles traveled, or it may be the result of the general economic conditions of the districts. On the other hand, the increased cost per bus mile for unimproved road may have resulted from similar changes in factors other than type of road. It is scarcely possible from these data to attribute definitely any decrease in the cost of pupil transportation to improved roads, and it is clear that if the type of road has any effect on cost, this effect is small compared to that of pupils transported and miles traveled.

Some buses make a practice of traveling empty to the end of the route fartherest from the school building, gathering the pupil load on the return trip. This procedure necessitates four one-way trips per bus per day, two loaded and two empty. The cost of pupil transportation is increased about 35 cents per bus per day for buses making these extra trips. The costs per bus mile and per pupil mile show increases in both contract and school-owned buses, with the tendency for the ratio of increase to be slightly more for school-owned buses.

TABLE 8. RELATION OF ROUTE MILEAGE ONE WAY TO COST OF PUPIL TRANSPORTATION, 748 BUSES, 1930-31

Route mileage per bus one way	School-owned transportation			Contract transportation		
	Pupils transported per bus per day, average	Transportation cost		Pupils transported per bus per day, average	Transportation cost	
		Per bus mile	Per pupil per day		Per bus mile	Per pupil per day
	Number	*Cents*	*Cents*	*Number*	*Cents*	*Cents*
Less than 4.5	26	50	15	18	30	11
4.5 - 9.49	36	27	11	34	29	12
9.5 - 14.49	45	19	10	40	24	13
14.5 - 19.49	49	15	10	46	19	14
19.5 or more	58	12	9	43	16	16

The average costs per bus mile and per pupil decrease as the length of the haul for school-owned buses increases (Table 8). The contract buses show an increased cost per pupil per day as the length of the route increases. The number of pupils per bus per day increases with the cost of transportation, indicating again the presence of the pupil factor.

Twenty-nine buses in Arkansas operated less than 1,000 bus miles each in 1930-31, and 37 operated more than 6,000 miles. The average mileage per bus per year for school-owned transportation was 3,512 miles, and for contract transportation 2,853. The cost of transportation varied more widely for contract buses than for school-owned ones when the buses were grouped according to the number of bus miles traveled.

Briefly summarizing the effect on cost of factors relating to bus routes, the analysis indicates little or no decrease in cost, depending on the unit of measurement, for buses operating on improved roads. The inter-relation of the mileage and pupil factors on the cost of transportation indicates that mileage is apparently an important factor in cost. The length of the bus route is a satisfactory unit for expressing the mileage factor because of the close relationship it bears to cost and to the other factors and because it may easily be determined.

School buses. Most studies on pupil transportation accounting take for granted that all school buses operate about the same number of days per year and these studies show no data on cost of operation for a spread of days per year. Perhaps, in a well established system of state pupil transportation, the difference in the number of days the bus operates is too small to be of any consequence. Pupil transportation, however, is relatively new in Arkansas and the number of days school buses operated in 1930-31 ranged from 20 to 180, with an average number of days operated under school-owned transportation of 151 and under contract transportation of 147. School-owned buses operating fewer days per year do so at a greater cost per day, whereas the cost per day for contract transportation increases with an increase in the number of days (Appendix Table 4). The cost per pupil per day decreases for school-owned and tends to remain constant for contract buses as the number of days increases.

The average cost of transportation per bus per day for school-owned buses having a seating capacity of 20-29 is $3.66 and for buses having a seating capacity of 60-69 the cost is $4.44 (Table 9). The range for contract buses similarly grouped is from $2.76 to $5.24, indicating again greater variation in the cost of contract transportation. Most of the preceding data indi-

TABLE 9. RELATION OF SEATING CAPACITY TO COST OF PUPIL TRANSPORTATION; 507 BUSES, 1930-31

Seating capacity per bus (pupils)	School-owned transportation			Contract transportation		
	Number of buses	Average cost		Number of buses	Average cost	
		Per bus per day	Per bus mile		Per bus per day	Per bus mile
		Dollars	*Cents*		*Dollars*	*Cents*
20 - 29	1	3.66	18.2	13	2.76	19.4
30 - 39	80	4.35	20.0	100	4.74	24.7
40 - 49	107	4.46	18.1	102	5.07	22.8
50 - 59	18	4.03	22.5	24	5.03	26.4
60 - 69	43	4.44	18.7	19	5.24	22.3

cate an apparent relation between the number of pupils transported and the cost of transportation, and the logical assumption is that capacity and cost should be similarly related because capacity is ordinarily associated with pupil load. However, the costs per bus per day and per bus mile show little difference for the various capacity groups for both school-owned and contract buses. An explanation for this unexpected relationship may be found in the fact that buses of larger carrying capacity do not haul correspondingly more pupils per day (Appendix Table 5). The tendencies for the cost per bus per year to show slight increases for wide changes in capacity, and for the cost per pupil per day to show small and inconsistent changes indicate that capacity is rather remotely related to cost and that the cost changes shown are occasioned by changes in capacity to a lesser degree than by changes in number of pupils transported per bus per day[4].

A most difficult relation, and one on which there are little data and much opinion, is that of cost of transportation to make of bus. The data on cost of transportation for Arkansas schools indicate little variation in the cost per bus mile for different makes of buses. The small variations shown may be accounted for by variations in such factors as pupils transported, mileage, and cost (new).

The number of pupils transported per bus per day changes from 33 to 56 when the cost (new) of the bus changes from "Less than $700" to "$1,300 or more" (Table 10). The changes in number of pupils transported are irregular and indicate that as a rule the medium priced buses transport as many pupils per day as the higher priced ones. The number of pupils per largest load per day changes less than the number per day, and tends to concentrate around 33 regardless of the cost of the bus. The cost per bus per day increases with the cost (new) of the bus. The costs per pupil per day and per bus mile show irregular changes, but in general these units decrease to the $1,000 bus cost level and increase thereafter. These data undoubtedly give weight to the belief that the cost of the bus is an important factor in the cost of pupil transportation due to the annual depreciation and interest charge.

TABLE 10. RELATION OF COST (NEW) OF BUS TO COST OF PUPIL TRANSPORTATION, 355 SCHOOL-OWNED BUSES, 1930-31

Cost (new) of bus and body	Number of buses	Puplis transported per bus, average		Cost of transportation		
		Per day	Largest load per day	Per bus per day	Per pupil per day	Per bus mile
Dollars		*Number*	*Number*	*Dollars*	*Cents*	*Cents*
Less than 700	12	33	32	3.34	10.2	19.2
700 - 799	24	39	34	3.65	9.3	14.2
800 - 899	58	38	33	3.86	10.3	17.7
900 - 999	54	49	36	4.03	8.2	15.8
1,000 - 1,099	97	44	33	4.40	10.0	18.7
1,100 - 1,199	55	42	32	4.69	11.1	20.8
1,200 - 1,299	25	43	36	5.04	11.8	21.2
1,300 or more	30	56	40	5.97	10.7	26.0

More than half the school-owned buses had been in use one year or less in 1930-31. There is a slight tendency for the cost of operation to decrease as the age of the bus increases, and this same tendency is noted in the salary of the bus driver. The maintenance charge increases as the bus advances in age. The older buses are operated over shorter routes and this fact may account for the apparent decrease in cost. In any event, the number of buses operating 3 or more years is too small to justify any conclusion relative to the effect of age of bus on cost of transportation.

A summary of the factors related to the school buses shows that the cost of transportation per bus per day decreases as the days operated increase up to 140 days per year; the seating capacity is remotely related to cost; school-owned buses are less expensive to operate than contract buses; and the cost (new) of the bus is important in determining the cost of transportation, while make and age of bus are seemingly not significant except as they affect inventory values.

Bus drivers. The median age of bus drivers operating school-owned buses in Arkansas is 28.2 years, and of those operating contract buses, 33.4 years. A surprisingly large number of bus drivers are less than 20 years of age, and relatively few are more than 45 years old. There is little relation between the age of the bus driver and the cost of pupil transportation other than a slight tendency for the cost per bus per day to be lower when the bus is driven by a younger driver. The decrease in cost is probably due to the fact that younger drivers receive smaller salaries for operating buses, since it can not be explained by an increase in the number of pupils transported or route mileage traveled.

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[4] The charge for depreciation is calculated from the cost (new) of the bus due to the straight line method of estimating depreciation and it is obvious that capacity and cost of transportation are closely related only when capacity and cost (new) of the bus are related. Since the correlation between seating capacity and cost (new) of the bus is .011, there is little relation between capacity and cost of pupil transportation.

School bus drivers are selected from patrons, pupils, and teachers. Relatively few of the contract drivers are pupils or teachers, but almost one-third of the school-owned buses are driven by pupils. The cost of pupil transportation per bus per day is about 6 per cent more when teachers rather than pupils are drivers, and about 15 per cent more when patrons rather than teachers are drivers (Table 11). School-owned buses driven by patrons operate fewer days per year but haul more pupils than buses operated by pupils or teachers. Buses operating under contract by teachers haul more pupils a greater number of days and travel more bus miles than buses driven by either patrons or pupils. Patrons receive an average of $250 per year for operating school-owned buses and pupils and teachers receive $157 and $189, respectively. Pupils and teachers are not paid according to services rendered, and the occupation of the bus driver is a cost factor in school-owned transportation because of differences in salary paid for operating buses.

TABLE 11. RELATION OF OCCUPATION OF DRIVER TO COST OF PUPIL TRANSPORTATION, 745 BUSES, 1930-31

Occupation of bus driver	School-owned transportation			Contract transportation		
	Number of buses	Average cost		Number of buses	Average cost	
		Per bus per day	Per pupil per day		Per bus per day	Per pupil Per day
		Dollars	*Cents*		*Dollars*	*Cents*
Patron	204	4.74	10	317	4.80	13
Pupil	110	3.87	9	67	4.05	13
Teacher	39	4.09	10	8	4.24	12

School districts. The average cost of transportation for school-owned buses operating in level areas is $1.12 per bus per day more than in hilly areas (Table 12). The data for contract transportation show that the cost per bus per day is more for the level and rolling areas than for the hilly, and less in the level

areas than the cost of school-owned transportation[5]. The school-owned buses operate over longer routes, transport more pupils, and travel a greater number of days per year than contract buses. These facts probably account for the higher cost of school-owned transportation, but do not explain why transportation costs are higher in the level areas. The number of days operated and the length of the bus route for the school-owned buses are about the same for both areas, and the difference in the number of pupils transported is not large enough to warrant the $1.12 increase in the cost per day. The contract buses in the hilly areas operate more days per year, but travel approximately the same length routes and transport a fewer number of pupils than contract buses in the level areas. The bus drivers are paid an average of $90.00 more per bus per year in level areas than in hilly, and the cost of maintenance, gas and oil, and property outlay is more for buses in the level areas, making for a higher unit cost per day (Appendix Table 6). The difference between the areas in the cost of wages, maintenance, and fuel is probably due to economic conditions, since it is not warranted by an increased load or mileage. In view of these facts, the conclusion is that the factor of topography of area, except as it affects economic conditions, has little to do with variations in the cost of pupil transportation in Arkansas.

TABLE 12. RELATION OF TOPOGRAPHY OF AREA TO COST OF PUPIL TRANSPORTATION, 748 BUSES, 1930-31

Topography	School-owned transportation			Contract transportation		
	Number of buses	Average cost		Number of buses	Average cost	
		Per bus per day	Per bus per mile		Per bus per day	Per bus per mile
		Dollars	*Cents*		*Dollars*	*Cents*
Level	31	5.49	22	61	4.77	25
Rolling	77	4.04	18	190	4.77	24
Hilly	247	4.37	19	142	4.46	24

A factor of efficient administration is economy in the purchase of supplies. Presumably, efficient administrators will purchase gas and oil at the lowest figure, which in most cases is termed "wholesale price." The wholesale purchase of supplies, gas, and oil for 238 buses owned and operated by the district apparently has the effect of lowering the costs of school-owned transportation per bus per day and per bus mile (Table 13). A

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[5] The topographical areas are classified from the physiographic map of the state. The data do not take into account the variations within or between districts but simply indicate roughly the effect of the general topography on the cost of transportation.

TABLE 13. RELATION OF HOW SUPPLIES ARE PURCHASED TO COST OF PUPIL TRANSPORTATION, 238 SCHOOL-OWNED BUSES, 1930-31

How supplies are purchased	Number of buses	Cost of transportation			Pupils transported per bus per year, average	Average distance traveled per bus per year
		Per bus per day	Per bus mile	Gas, oil and maintenance per bus mile		
		Dollars	*Cents*	*Cents*	*Number*	*Miles*
Gas wholesale supplies wholesale	60	4.29	18.7	5.8	6,087	3,527
Gas retail supplies retail	127	4.49	19.2	5.9	6,546	3,548
Gas wholesale supplies retail	41	4.48	20.8	5.0	6,519	3,246
Gas retail supplies wholesale	10	3.64	22.0	6.1	5,472	2,320

further analysis, however, of these data (Appendix Table 7) indicates that the obtained differences in cost of pupil transportation per bus per day are not significant. This does not mean that, in general, wholesale purchasing does not reduce cost, but simply that because of the small saving possible and the operation of other factors, no significant reduction in cost was found for buses reported in this study.

Significance of factors. The foregoing data show certain differences in the average cost of transportation between different groupings; for example, in Table 7 the average cost per bus per day for buses transporting less than 20 pupils is $3.50 and for buses transporting 20-29 pupils the cost is $4.02. The difference in cost is ascribable to differences in the number of pupils transported. Likewise, the differences found in other tables are attributed to certain indicated factors, and the question may arise as to the justification for assigning these differences in cost to the various factors rather than to sampling errors.

A statistical analysis of the five important factors affecting cost was made to determine their significance[6]. The analysis shows that the two managerial factors, cost of bus and type of bus driver, and the two factors over which the school authorities have little control, the length of the bus route and the number of pupils transported per bus per day, have a highly significant effect on the cost of pupil transportation in Arkansas.

PREDICTING COST OF PUPIL TRANSPORTATION

The preceding data show that changes in certain factors, such as pupils transported and miles traveled, are accompanied by changes in the cost of transportation. This suggests that when the factors are known, the cost may be estimated. Ordinarily these factors are determined before the school consolidation is completed and may be used in predicting the cost of transportation, which cost, in many instances, proves to be the limiting factor in the success of a consolidation program. The common method of arriving at the mathematical relationship between the factors affecting cost and the cost of transportation, consists in formulating multiple regression equations. Certain facts, however, concerning the data of the study should be known before the equations are calculated.

It should be remembered that the cost of school-owned transportation is a summation of various costs, such as gas, oil, salary, and overhead charges; and the cost of contract transportation presumably represents the amount in dollars and cents of what the contractor estimates the transportation will cost, plus a reasonable profit. It seems on first thought that perhaps the latter is the more nearly correct approximation of true cost since it presumably represents a cost derived from the bids of a number of individuals and is not subject to the errors of estimate that necessarily creep into summations of the cost of school-owned transportation which include estimates of cost of such items as interest, depreciation, overhead, and administration that are difficult to determine. Then, too, this contract price is not subject to the errors of accounting and transferring lists of figures, since only one figure for each bus is used.

Certain facts, however, tend to discount the theory that the contract price is the result of competitive bidding; and the data rather suggest that the contract bid for transportation is based on the maximum state allowance for transportation rather than the cost plus profit basis. Obviously, if the cost of transportation is based on a formula for estimating cost, the data are useless in serving as a basis for arriving at any other mathematical expression of cost, since the equation would resolve itself into the original equation from which the bids were made. The data of this study, therefore, are examined to determine the basis of their origin.

Probably the most satisfactory technique for determining whether the cost data are influenced by the reimbursement schedules set up by the State Department of Education consists in comparing the actual reported cost of pupil transportation with the calculated state allowance for each bus, and this technique is used in this study. The procedure consists in correlating the actual reported cost of pupil transportation per bus per year with the maximum state allowance calculated according to the regulations of the Arkansas State Department of Education.

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[6] Fisher's method of analysis of variance is used for the statistical treatment of the results reported in this bulletin. The method facilitates the isolation of factors and provides an appropriate test of significance. G. W. Snedecor in his Calculation and Interpretation of Analysis of Variance and Covariance (Collegiate Press, Ames, Iowa) has furnished a simply explained and efficient method of computation.

The analysis of variance shows that all factors except that of "purchase of supplies" have a highly significant effect on the cost of transportation. The found value of "F" for purchase of supplies is considerably less than the five per cent point and indicates that no significant difference in the cost of pupil transportation may be ascribable to this factor (Table 7 of the Appendix).

The cost data for school-owned buses show a relatively low correlation with the estimated state equalization allowance[7]. One would expect a rather high degree of relationship between actual cost and state allowance, but the correlation obtained does not meet expectations. While this fact may imply that the cost data secured from the school districts do not approximate the cost of transportation, this is quite unlikely in view of the fact that these data originated in the school districts and constitute the amount requested from the state as a reimbursement for the transportation expenditure. The average amount requested per bus per year is $153.00 less than the average state allowance, and it seems quite unlikely that a local board of education would under-estimate cost to this extent when expecting a state equalization allowance. This leads to the conclusion that the state equalization allowance does not represent the actual cost of transportation.

These conclusions are strengthened by examining the correlation data for contract buses. The correlation between the cost of transportation and the state allowance is relatively high[8]. Since the state equalization allowance does not represent the actual cost, one would expect to find variations between actual cost and state allowances for contract buses similar to those found in school-owned transportation. This would be true provided the bids for contract transportation were actually competitive and based on the cost of transportation. The high degree of relationship between averages for contract cost and equalization must be interpreted to mean that the contract bids in most cases simply represented the maximum state allowance for transportation, and the successful bidder was selected by the local board of education to receive an amount approximately equal to the maximum state allowance.

Since the cost of contract transportation does not approximate the actual cost but rather represents the maximum state allowance, it is clear that any equation of cost based on these data would simply revert to an equation representing the method used by the state in calculating the allowance for transportation. The data on the cost of school-owned transportation do not seem to be affected by the state allowance, and, as they are shown to be more nearly representative of the actual cost, they are used in measuring the effect of the factors on the cost of pupil transportation[9].

The factor analysis shows that two types of factors have a significant effect on the cost of pupil transportation—those due to business management and those due to conditions largely beyond the control of the school. It is doubtless evident that such factors of business management as cost (new) of the bus and occupation of the driver contribute more to making up the total cost of transportation than does the number of pupils transported or the route mileage. The average depreciation alone is $207 per bus per year, representing approximately one-third the average yearly cost of transportation. (See Table 4.) It is evident that a high degree of relationship exists between the cost (new) of the bus and the annual cost of transportation, but obviously this is due to the fact that the item of depreciation is a proportionate part of the cost (new) of the bus. A correlation, therefore, between cost (new) of the bus and cost of transportation is spurious, since it would in effect show the relationship between the total cost of transportation and a proportionate part of this cost. Similarly, the relationship existing between cost of transportation and occupation of the bus driver shown in Table 11 is due to the fact that the salary paid to patron drivers is higher than that paid to teachers or pupils for apparently no other reason than that they are patrons.

Then, too, if managerial factors are to be used in arriving at equations of cost, it is desirable that some consistency be shown in managerial practices carried out under similar circumstances. This is another way of saying that, if the occupation of the bus driver is used in arriving at an equation of cost, there should be some relation between the occupation of the driver and the conditions of transportation. High priced buses and high salaried drivers are not peculiar to any similar conditions surrounding transportation in Arkansas. In view of these facts, the judgment of the writer is that the most satisfactory factors to use as a basis for predicting the cost of pupil transportation are route mileage and pupils transported per bus per day.

Plan I; Predicting cost from natural factors. The cost predictions are based on the changes in the cost of transportation brought about by changes in the route mileage and the pupils

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[7] The correlation between the actual cost of transportation and the state allowance for the 355 Arkansas school-owned buses is .487. PE of r is .027.

[8] The correlation between the actual cost of transportation and the state allowance for the 393 Arkansas contract buses is .888. PE of r is .007.

[9] Since a great majority of school-owned buses operate 140 to 169 days and apparently those operating less than 140 days are special cases due to the newness of the program of transportation, it is believed that the accuracy of the measurement will be increased by using the data of the 309 school-owned buses operating 140 to 169 days per year. The cost per bus per day represents a proportionate part of the current expense and property outlay costs, is related to the important factors affecting cost, and may be used in linear regression equations. These characteristics make this unit more satisfactory than the other units mentioned for cost predictions and it is therefore used as the basis for the predictions of pupil transportation cost.

TABLE 14. ESTIMATES OF DAILY COST OF PUPIL TRANSPORTATION PER BUS IN ARKANSAS

Pupils per bus per day	Daily cost of transportation for a route mileage one way of									
	4 Miles	6 Miles	8 Miles	10 Miles	12 Miles	14 Miles	16 Miles	18 Miles	20 Miles	25 Miles
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
15	3.39	3.49	3.58	3.69	3.79	3.89	4.00	4.10	4.20	4.45
20	3.48	3.58	3.68	3.78	3.88	3.99	4.09	4.19	4.29	4.54
25	3.57	3.67	3.77	3.87	3.98	4.08	4.18	4.28	4.38	4.64
30	3.66	3.76	3.86	3.97	4.07	4.17	4.27	4.37	4.47	4.73
35	3.75	3.85	3.96	4.06	4.16	4.26	4.36	4.46	4.57	4.82
40	3.84	3.94	4.05	4.15	4.25	4.35	4.45	4.56	4.66	4.91
45	3.93	4.04	4.14	4.24	4.34	4.44	4.55	4.65	4.75	5.00
50	4.03	4.13	4.23	4.33	4.43	4.54	4.64	4.74	4.84	5.10
55	4.12	4.22	4.32	4.42	4.52	4.63	4.73	4.83	4.93	5.19
60	4.21	4.31	4.41	4.51	4.62	4.72	4.82	4.92	5.02	5.28
65	4.30	4.40	4.50	4.61	4.71	4.81	4.91	5.01	5.12	5.37
70	4.39	4.49	4.60	4.70	4.80	4.90	5.00	5.10	5.21	5.46
80	4.58	4.68	4.78	4.88	4.98	5.08	5.19	5.29	5.39	5.64
90	4.76	4.86	4.96	5.06	5.17	5.27	5.37	5.46	5.57	5.83
100	4.94	5.04	5.14	5.25	5.35	5.45	5.55	5.65	5.76	6.01

transported in the 309 school-owned buses operating 140-169 days per year. The cost of transportation increases 10 cents per bus per day for each increase of 2 miles of route and 9 cents per bus per day for each increase of 5 pupils transported per day[10]. Estimates of the probable cost of transportation for various combinations of the two factors show that the average cost per bus per day for buses operating over routes 4 miles one way, and transporting 15 pupils per day, is $3.39 (Table 14). The chances are 68 in 100 that the true cost will not vary more than $1.04 from these estimates, and a variation of $3.12 should include the cost of practically all buses.

Summarizing the characteristics of the plan, one may say that it conforms to established principles, in that it is based on factors beyond the control of the school authorities, represents average expenditures for transportation under similar circumstances, need not be computed separately from other functions of the school, and is flexible to the extent of recognizing two influential factors affecting the cost of pupil transportation in Arkansas. The plan, however, has some disadvantages. In the first place, there is no evidence to indicate that the average program is the most satisfactory or even the most economical program. In fact, the large number of contract buses having locally constructed bus bodies[11] would seem to indicate that a state would

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[10] The estimates are obtained from the regression of route mileage one way (A) and pupils transported per bus per day (B) on cost of transportation in dollars per bus per day (Y). The means for the three variables are 12.09, 45.16, and $4.35; and the standard deviations are 5.1, 20.1, and $1.16, respectively. The zero order correlations are: $AY=.351$, $BY=.407$, and $AB=.406$. The multiple R is .45, and $Y=.0508A$ plus $.0183B$ plus 2.91. The reduction in variability is 11 per cent.

[11] Sixty-three per cent of contract as compared with 21 per cent of school-owned buses have locally constructed bus bodies.

perhaps do well to base aid on standard rather than average practices. Then, too, the low relationship between route mileage and pupils transported, and cost of transportation causes one to question the reliability of any estimate of cost arrived at entirely by means of factors beyond the control of local boards of education. These facts, together with the high relationship between cost of transportation and the managerial factors, such as cost of bus, salary of bus driver, and transportation policies, strengthened by the apparent tendency for the maximum allowance to become the cost of contract transportation, suggest that at least some consideration be given to alternative plans based in part on the managerial factors.

Plan II; Predicting cost from natural and managerial factors. The data suggest that the current expense incident to pupil transportation may be predicted from the route mileage one way and pupils transported per bus per day. This implies that the total cost of pupil transportation, which is a summation of the current expense and property outlay, may be predicted from separate estimates of these two items of cost. Estimates of probable current expense for various combinations of route mileage and pupils transported indicate that the current expense incident to pupil transportation is $1.94 per bus per day for buses transporting 15 pupils 4 miles, and increases 6 cents per bus per day for each five pupils, and 11 cents per bus per day for each 2 miles of route[12].

The use of this multiple regression will not account for the item of capital outlay. This item represents depreciation and interest charges which, according to the technique used in this study, are calculated from the cost (new) of the bus and the inventory value of buildings and equipment. The analysis of factors provides justification for separating the item of capital outlay from that of current expense. Depreciation is an important item in the total cost and is remotely related to the number of pupils transported and the route mileage. This lack of relationship is explained by the facts that the cost (new) of the bus is remotely related to the factors affecting cost and little variation is shown in the cost (new) of the bus due to the large number of low priced chasses used for buses of various carrying capacities. These facts suggest that a better prediction of the depreciation and interest charges may be obtained from the average cost of the bus rather than from a combination of route mileage and pupils transported. This implies that standards are needed for determining the cost (new) of the bus. Since it is the current practice in Arkansas to use low priced chasses for practically all buses, the only essential difference in the cost (new) of the buses should be that due to the variation in cost occasioned by differences in seating capacity[13].

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[12] The estimates are obtained from the regression of route mileage one way (A) and pupils transported per bus per day (B) on current expense of transportation in dollars per bus per day (Y). The mean of Y is $2.74 and the standard deviation $0.99. The zero order correlations are: $AY=.38$, $BY=.41$, and $AB=.36$. The multiple R is .44, and the equation is Y equals $.0548A$ plus $.0119B$ plus 1.54. The standard error of estimate is $0.89 and the reduction in variability 11 per cent.

The use of Plan II in predicting cost should reduce the error occasioned by attempting to estimate the cost of depreciation and interest from pupils transported and miles traveled. The use of standard specifications for body construction assures safety and comfort for all the pupils and provides a justification for requiring the contractors of transportation to use safe and comfortable buses, since the maximum allowance is estimated on the basis of the cost of approved types of buses. This plan, however, is not without its objections, one of which is the error in estimating current expense from the regression of route mileage and pupils transported. The standard error of estimate may result in extreme cases in variations from actual cost of $2.67 per bus per day or $400.00 per bus per year.

The error in estimating current expense may be further reduced by modifying the technique employed in Plan II to include some managerial factors relating to current expense, in separate estimates of cost. For example, items of cost such as salary of driver and charge for insurance may be determined by standard practices established by state school authorities rather than by natural factors. The cost of gas, oil, and maintenance ordinarily depends on natural factors and may be estimated therefrom[14]. Cost estimates of the remaining items making up the total cost are dependent primarily on transportation practices and policies rather than natural conditions. These estimates, therefore, can not be arrived at with any degree of accuracy until standards are established.

These arguments may be briefly summarized by simply stating that estimates of cost should be based on items of cost. If the cost of these items is determined by factors beyond the con-

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[13] One manufacturer's price for an all steel body conforming to the state specifications with 24 intermediate (13-inch) pupil stations is $645.00. This price increases approximately $11 per pupil station for buses carrying up to 43 pupils. Bus body manufacturers recommend more expensive chasses than those indicated above for buses carrying more than 43 pupils per load. The use of these or similar estimates is suggested as a basis for estimating the annual depreciation per bus by the straight line method. The interest charge should be added to the depreciation charge to complete the total capital outlay. The annual interest charge is calculated at the rate of 5 per cent of the average yearly value of the transportation equipment which includes buses, tools, and buildings. Few districts provide school-owned equipment other than buses, and for those districts that provide buildings and equipment the average interest and depreciation charge is approximately $10.00 per bus as shown by the data of this study. Since the cost of the bus is charged off at the end of 5 years, the annual interest charge for capital invested in school buses may be arrived at by calculating 5 per cent of one-half the value of the bus, or to simplify the arithmetic, 2.5 per cent of the cost (new) of the bus, making the total depreciation and interest charge for predictive purposes 22.5 per cent per year of the cost (new) of the bus plus $10.00.

[14] The regression equation from which these estimates may be calculated is: Cost of fuel and maintenance in dollars per bus per day equals .0415 (route miles one way) plus .0046 (pupils transported per bus per day) plus $0.99.

trol of individuals, these factors may be used in arriving at cost. If, on the other hand, these cost items are determined by individuals, the accuracy of a prediction of cost depends upon managerial policies rather than upon natural conditions. The use of managerial factors in arriving at estimates of cost of pupil transportation will probably require more careful administration of pupil transportation, especially in the State Department of Education. Contracts and estimates of cost will need more careful scrutiny, due to the abandonment of the "rule of thumb" method for estimating cost. Reliable estimates of cost based on managerial factors are easily made from established standards, but may be extremely unreliable in the absence of standards.

Summary and Conclusions

This study deals with a determination of the important factors affecting the cost of pupil transportation in Arkansas and cost predictions based upon these factors. The cost data were obtained from 935 vehicles operating in 261 Arkansas school districts receiving state aid for pupil transportation in 1930-31.

The cost of pupil transportation in Arkansas varies for different units of measurement and within different units of measurement for different types of ownership. The average cost per pupil per year is $15.21 for school-owned, $18.84 for contract, and $17.65 for private transportation. The cost per bus per year is $662, $685, and $70, respectively, for the three types of ownership. The cost per bus per day for school-owned and contract transportation is $4.39 and $4.66, and the cost per bus mile is 19 cents and 24 cents, respectively.

The number of pupils transported has a significant effect on the cost of pupil transportation and the most satisfactory basis for measuring this effect is the number of pupils transported per bus per day. There is no apparent difference in cost for type of road, but the length of the route affects the cost of transportation, and the route mileage one way is used for measuring this effect. The number of days in excess of 140 has little or no effect on the cost of transportation per bus per day. School-owned buses provide the most economical transportation, and the cost of the bus is the most important factor in determining the cost of pupil transportation. The occupation of the bus driver has an appreciable effect on the cost of transportation and bus drivers are not paid according to the number of pupils transported or miles traveled. The topography of the district and factors having to do with purchasing policies show no significant relationship to cost.

Two plans are presented and a third suggested for predicting the cost of pupil transportation. The cost prediction in Plan

I is based upon the one way route mileage and the number of pupils transported per bus per day. This plan has the advantage of a cost estimate based upon factors beyond the control of the local school authorities and results in estimates of cost that are more nearly representative of true cost than the estimates obtained from the present plan used in Arkansas. Plan II is derived from a combination of natural and managerial factors in which the natural factors of route mileage and pupils transported are used as a basis for predicting the current expense of the bus, and the managerial factor, cost (new) of bus, is used to estimate the capital outlay. The technique of Plan II suggests the possibility of a further separation of items making up current expense, so that estimates of cost based upon managerial factors established by standard practices may further reduce the error of estimate occasioned by attempting to predict cost from factors that are not entirely reliable as forecasters of cost. This plan precludes the use of the "rule of thumb" method for wholesale estimates of cost and suggests that each school bus is a separate unit and should be so regarded in the estimate of cost.

This study shows a need for additional information concerning administrative costs and practices, depreciation and interest charges, and more uniformity in reporting cost. There is a need for standard managerial practices in the selection of transportation equipment, payment of wages, and purchasing of supplies and insurance. The study suggests that individual estimates for each unit of transportation should be made and revised from year to year to prevent injustice and waste in payments for contract transportation. The practice of paying the actual cost of transportation is commended and should be continued, but care must be exercised in estimating this cost. The high cost of pupil transportation shows the need for carefully planned transportation and consolidation programs. The implications of these data suggest the need for additional information on the efficiency and economy of instruction in the smaller schools where less extensive transportation programs are needed.

APPENDIX

TABLE 1. UNIT COST OF PUPIL TRANSPORTATION, 355 SCHOOL-OWNED BUSES, 1930-31

Item of Cost	Cost per unit of measurement				
	Per bus per day	Per bus mile	Per pupil per year	Per pupil per day	Per pupil mile
	Dollars	*Cents*	*Dollars*	*Cents*	*Cents*
Salary of driver	1.42	6.1	4.97	3.3	.2
Gas and oil	.87	3.7	3.01	2.0	.1
Maintenance	.41	1.8	1.36	0.9	.1
Insurance and storage	.05	0.2	.15	0.1	*
Depreciation	1.38	5.9	4.82	3.2	.2
Interest	.26	1.2	.90	0.6	*
Total	4.39	18.9	15.21	10.1	.6

*Less than .1 of one cent.

TABLE 2. RELATION OF AGGREGATE NUMBER PUPILS TRANSPORTED PER BUS PER YEAR TO COST OF PUPIL TRANSPORTATION, 355 SCHOOL-OWNED BUSES, 1930-31[1]

Aggregate No. of pupils transported per bus per year	Number of buses	Pupils transported per bus per day, average	Average length of bus route one way	Cost of transportation		
				Per bus per day	Per pupil per day	Per pupil mile
		Number	*Miles*	*Dollars*	*Cents*	*Cents*
Less than 1,000	1	12	4	1.39	11.7	1.5
1,000 - 1,999	4	34	10	6.22	18.5	1.0
2,000 - 2,999	18	20	7	3.62	18.2	1.4
3,000 - 3,999	31	23	9	4.08	17.5	1.0
4,000 - 4,999	50	30	11	4.13	13.9	.7
5,000 - 5,999	75	36	11	4.21	11.6	.6
6,000 - 6,999	50	42	12	4.43	10.5	.5
7,000 - 7,999	37	49	14	4.38	8.9	.5
8,000 - 8,999	27	55	13	4.64	8.4	.6
9,000 - 9,999	20	61	16	4.63	7.6	.4
10,000 or more	42	78	16	5.19	6.7	.5

[1] The aggregate number transported per year is the cumulative total of the number transported each day of the school year.

TABLE 3. RELATION OF TYPE OF ROAD AND ROUTE MILEAGE TO COST OF PUPIL TRANSPORTATION, 355 SCHOOL-OWNED BUSES, 1930-31

Type of road	Route mileage per bus one way for type of road indicated	Number of buses	Average length of bus route one way	Pupils transported per bus per day, average	Cost of transportation	
					Per bus per day	Per bus mile
			Miles	*Number*	*Dollars*	*Cents*
Paved	Less than 4.5	28	11	46	4.35	19.6
	4.5 - 8.49	35	13	46	4.58	18.4
	8.5 - 12.49	17	13	56	4.56	18.4
	12.5 or more	6	23	65	6.14	13.4
Gravel	Less than 4.5	37	11	48	4.25	20.4
	4.5 - 8.49	35	12	40	4.37	19.4
	8.5 - 12.49	15	14	59	4.92	19.0
	12.5 or more	16	20	46	4.53	11.7
Dirt	Less than 4.5	7	3	30	3.46	46.7
	4.5 - 8.49	57	6	32	3.90	29.6
	8.5 - 12.49	53	11	43	4.49	21.7
	12.5 or more	60	17	32	4.53	14.1

TABLE 4. RELATION OF DAYS OPERATED PER YEAR TO COST OF PUPIL TRANSPORTATION, 748 BUSES, 1930-31

Days operated per bus per year	School-owned transportation			Contract transportation		
	Number of buses	Average cost per day		Number of buses	Average cost per day	
		Per pupil	Per bus		Per pupil	Per bus
		Cents	*Dollars*		*Cents*	*Dollars*
Less than 130	23	13	4.97	49	12	4.02
130 - 139	21	10	4.76	23	13	4.21
140 - 149	15	11	4.34	26	14	4.71
150 - 159	226	10	4.37	242	13	4.86
160 - 169	68	9	4.27	52	13	4.29
170 or more	2	8	4.45	1	24	5.00

TABLE 5. RELATION OF SEATING CAPACITY TO NUMBER OF PUPILS TRANSPORTED AND COST OF PUPIL TRANSPORTATION, 249 SCHOOL-OWNED BUSES, 1930-31

Seating capacity per bus	Pupils transported, average			Average length of bus route one way	Cost of transportation	
	Per bus per day	Per bus per load: Average load per day	Per bus per load: Largest load per day		Per bus per year	Per pupil per day
	Number	*Number*	*Number*	*Miles*	*Dollars*	*Cents*
20 - 29	22	22	22	10	436	16.8
30 - 39	39	26	29	10	656	11.2
40 - 49	44	29	34	12	672	10.1
50 - 59	45	31	33	9	624	9.0
60 - 69	46	37	40	12	686	9.6

TABLE 6. RELATION OF TOPOGRAPHY TO DRIVER'S SALARY, COST OF GAS AND OIL, MAINTENANCE, AND DEPRECIATION OF TRANSPORTATION, 355 SCHOOL-OWNED BUSES, 1930-31

Topography	Average salary of driver per bus per year	Average cost of gas and oil per bus per year	Average cost of maintenance per bus per year	Average cost of depreciation per bus per year
	Dollars	*Dollars*	*Dollars*	*Dollars*
Level	297	164	98	222
Rolling	203	122	53	180
Hilly	207	129	60	214

TABLE 7. ANALYSIS OF VARIANCE OF FACTORS AFFECTING THE COST OF PUPIL TRANSPORTATION, 355 SCHOOL-OWNED BUSES, 1930-31

Source of variation	Sum of squares	Degrees of freedom	Mean square	Values of F: Found	Values of F: 1% point	Values of F: 5% point
Route mileage	54.14	4	13.53	19.47	3.38	2.41
Pupils per bus per day	99.44	9	11.49	16.53	2.57	1.97
Cost (new) of bus	139.68	7	19.95	28.71	2.86	2.13
Occupation of driver	59.77	2	29.88	43.00	4.68	3.03
Purchase of supplies[1]	3.59	4	.90	1.28	3.38	2.41
Remainder	227.86	328	.70			
Total	584.48	354				

[1] When the difference (.2241) between the pair of means designated as "gas wholesale supplies wholesale" and "gas retail supplies retail" (Table 13) is divided by its standard error (.1304) the quotient is 1.72, a value that is not significant.

FACTOR SHEET FOR COMPARING THE AVERAGE OF 748 ARKANSAS SCHOOL BUSES WITH BUS NUMBER ________

Factors for comparison		1930-31 averages: School-owned buses	1930-31 averages: Contract buses	Bus number
THE COST OF PUPIL TRANSPORTATION				
Per pupil per year	*Dollars*	15.21	18.84	
Per pupil per day	*Cents*	10.1	12.8	
Per pupil mile	*Cents*	.6	.7	
Per bus per year	*Dollars*	662.00	685.00	
Per bus per day	*Dollars*	4.39	4.66	
Per bus mile	*Cents*	18.9	24.0	
Driver's salary per bus mile	*Cents*	6.1		
Gas and oil per bus mile	*Cents*	3.7		
Maintenance per bus mile	*Cents*	1.8		
Insurance, storage per bus per yr.	*Dollars*	7.69		
Depreciation per bus per year	*Dollars*	207.46		
Interest per bus per year	*Dollars*	40.24		
THE SCHOOL BUSES				
Age	*Years*	1.76		
Seating capacity	*Number*	43	40	
Cost (new)	*Dollars*	1,032.00		
Days operated per year	*Number*	151	147	
Median age of bus driver	*Years*	28	33	
Round trips per day	*Number*	2.0	1.7	
Distance traveled per year	*Miles*	3,512	2,853	
THE BUS ROUTES				
Length of route per bus one way	*Miles*	12.0	9.8	
Part of route paved	*Per cent*	15.0	6.0	
Part of route gravel	*Per cent*	17.0	21.0	
Part of route dirt	*Per cent*	68.0	73.0	
Bus routes per bus	*Number*	1.5	1.2	
Mileage in level area	*Per cent*	9	15	
Mileage in other area	*Per cent*	91	85	
THE PUPILS TRANSPORTED				
Pupils per bus per day	*Number*	44	36	
Pupils per bus per load	*Number*	35	32	
Pupils ¼ mile from bus line	*Per cent*	58	65	
Pupils 1 or more miles from line	*Per cent*	20	20	
One way distance transported	*Miles*	5	6	
THE SCHOOL DISTRICTS		1930-31 Average		
Pupils in average daily attendance	*Number*	260		
Pupils transported per day	*Number*	118		
Part of attendance transported	*Per cent*	45		
School-owned buses per district	*Number*	1.4		
Contract buses per district	*Number*	1.5		
Annual current expense	*Dollars*	8,000.00		
Annual cost of transportation	*Dollars*	1,700.00		
Part of current cost spent for transportation	*Per cent*	19		

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